Three-dimensional Orographic Precipitation Enhancement Observed in OLYMPEX

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See poster 244

Identification of Mesoscale Convective Precipitation in GPM Data

Robert Houze and Stacy Brodzik
PMM Science Team Meeting
San Diego, CA
October 16-20, 2017

REVIEW ARTICLE

The variable nature of convection in the tropics and subtropics: A legacy of 16 years of the Tropical Rainfall Measuring Mission satellite

Robert A. Houze Jr.[1], Kristen L. Rasmussen[2], Manuel D. Zuluaga[3], and Stella R. Brodzik[1]

August 2015

The TRMM study identified categories of convective and stratiform echoes based on their <u>3D</u> structure

Object	Echo Characteristic	Height	Area
Isolated Shallow Echoes	> min detectable	< 4 km	2 pixels
Deep Convective Cores	> 40 dBZ (strong)	> 10 km	N/A
	> 30 dBZ (moderate)	> 8 km	N/A
Wide Convective Cores	> 40 dBZ (strong)		> 1000 km² at some altitude
	> 30 dBZ (moderate)		> 800 km² at some altitude
Broad Stratiform Regions	Contiguous stratiform		> 50,000 km² (strong)
			> 30,000 km² (moderate)
			30-50,000 km² (filtered)

An Example of the TRMM Results

Deep Convective Cores (strong)
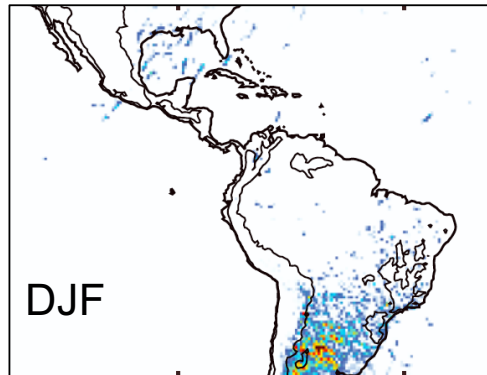
Frequencies of occurrence

See Houze et al. 2015 for full low-latitude patterns of these features

Wide Convective Cores (strong)
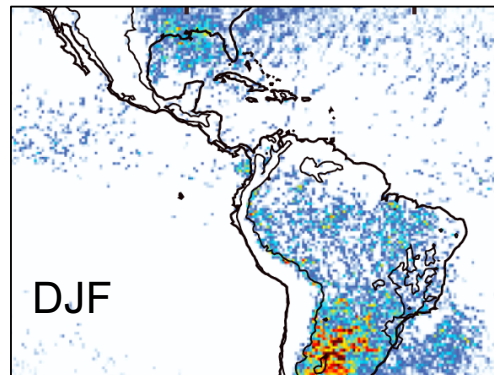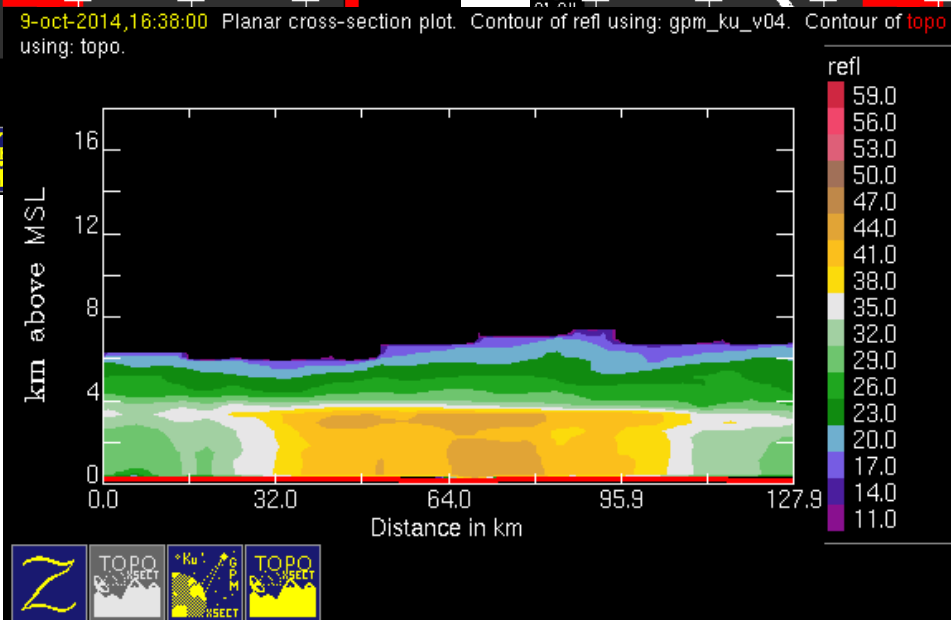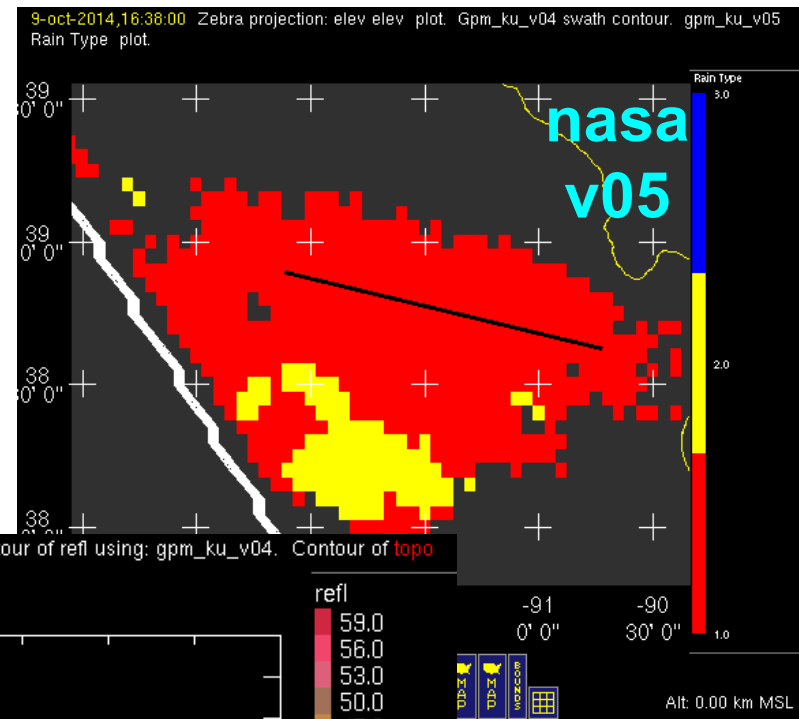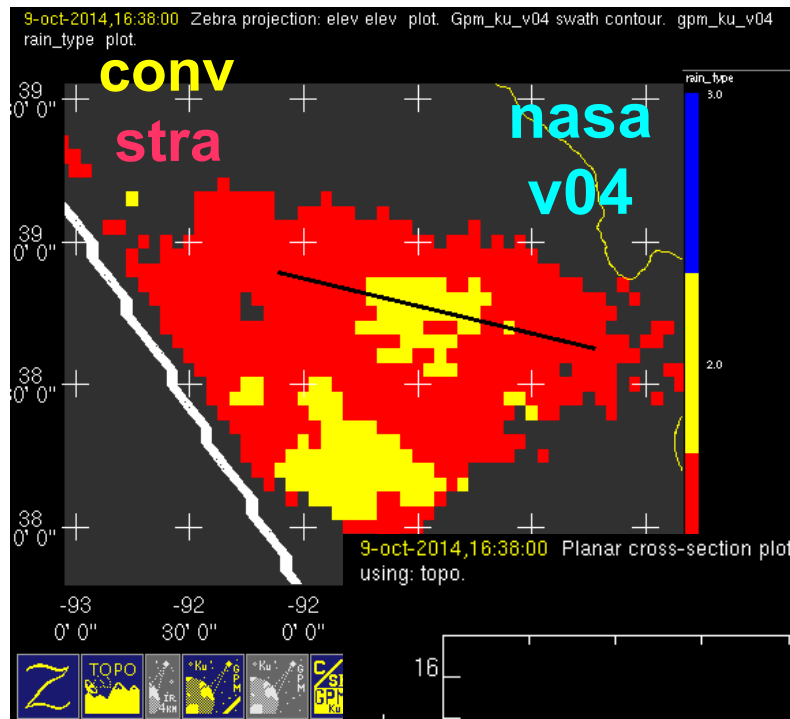

Broad Stratiform (strong)
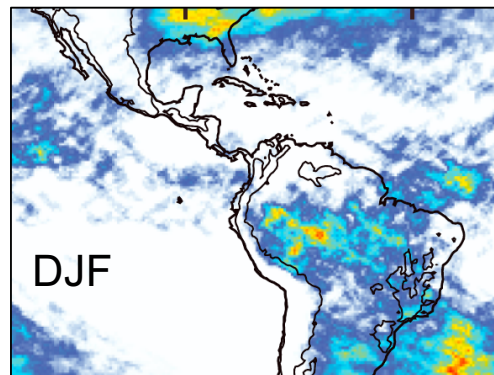
GPM Goal:

Extend this work to higher latitudes

Problem:

- V4 classified a lot of Ku stratiform echo as convective

- V5 corrected much of this problem

Example of successful correction

conv
stra
nasa
v04

nasa
v05

9-oct-2014,16:38:00 Zebra projection: elev elev plot. Gpm_ku_v04 swath contour. gpm_ku_v04 rain_type plot.

9-oct-2014,16:38:00 Zebra projection: elev elev plot. Gpm_ku_v04 swath contour. gpm_ku_v05 Rain Type plot.

9-oct-2014,16:38:00 Planar cross-section plot. Contour of refl using: gpm_ku_v04. Contour of topo using: topo.

October
Missouri

(20141009/1637
)

HUGE
improvement

But problems remain

Problem case: East Coast Front
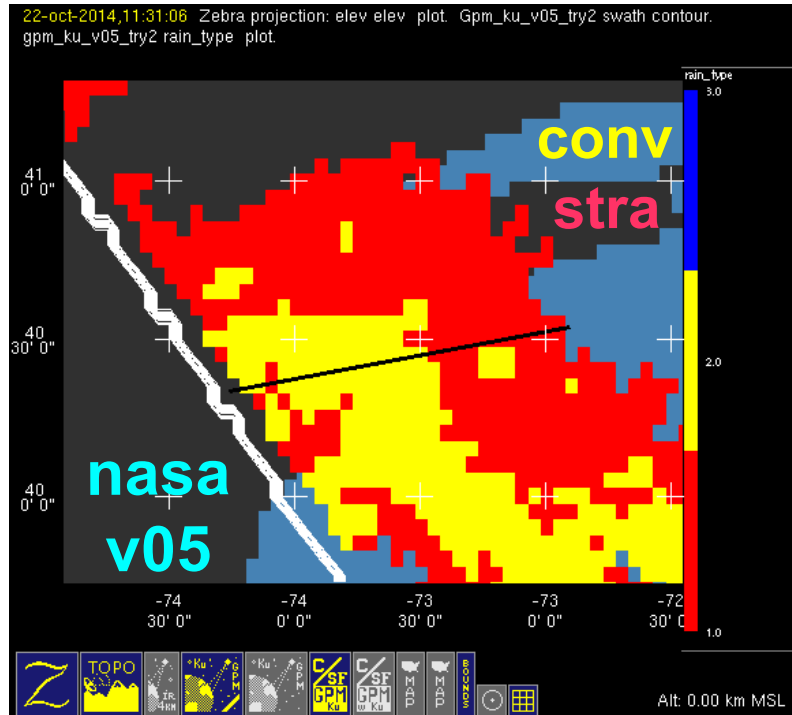
October
NE U.S.
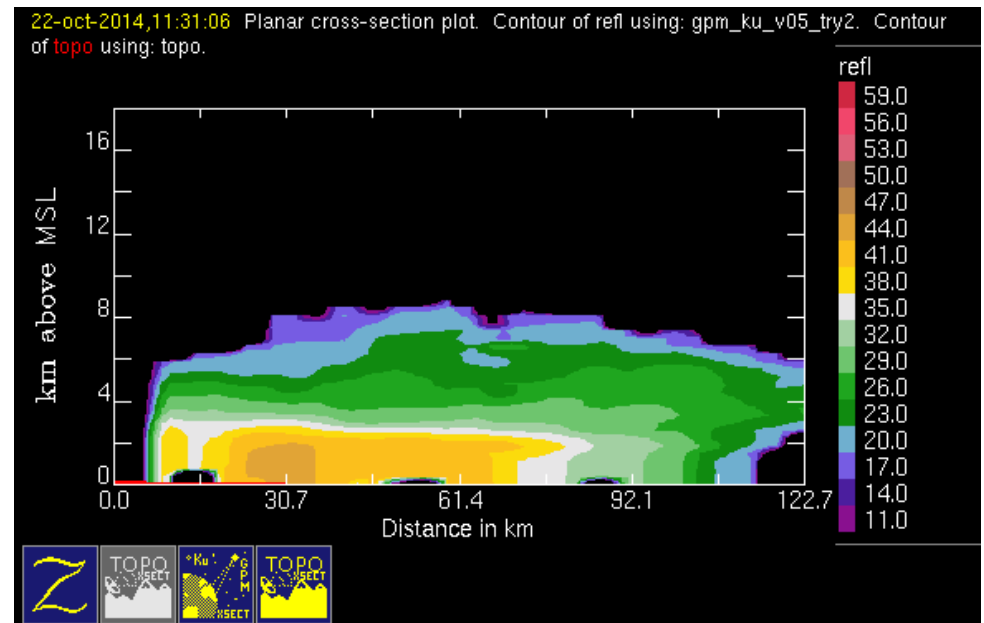
(20141022/1132)

Problem case: West Coast Front
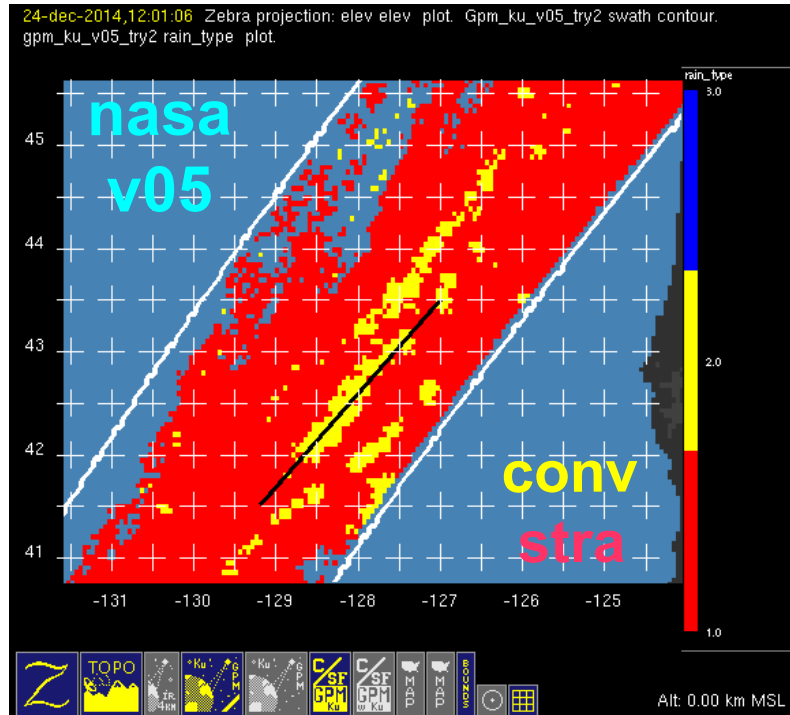
December
NW coast of U.S.
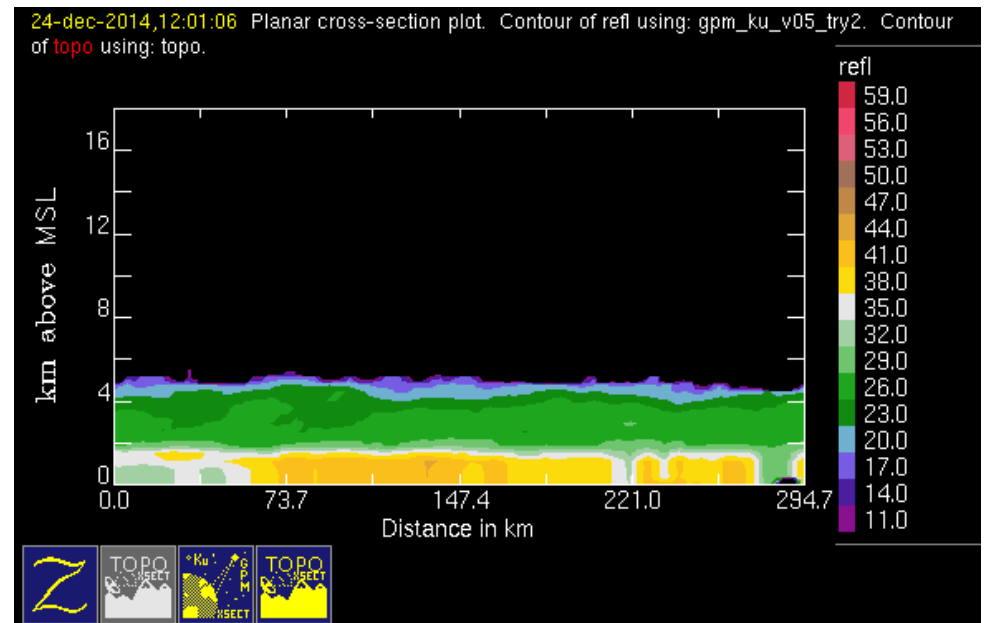
(20141224/1202)

Problem case: North Pacific
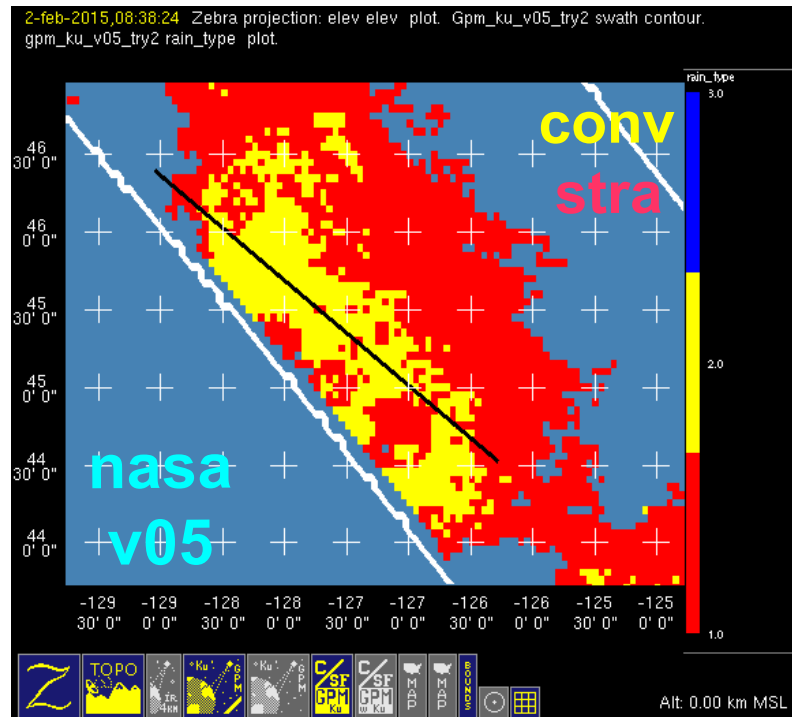
February
North Pacific
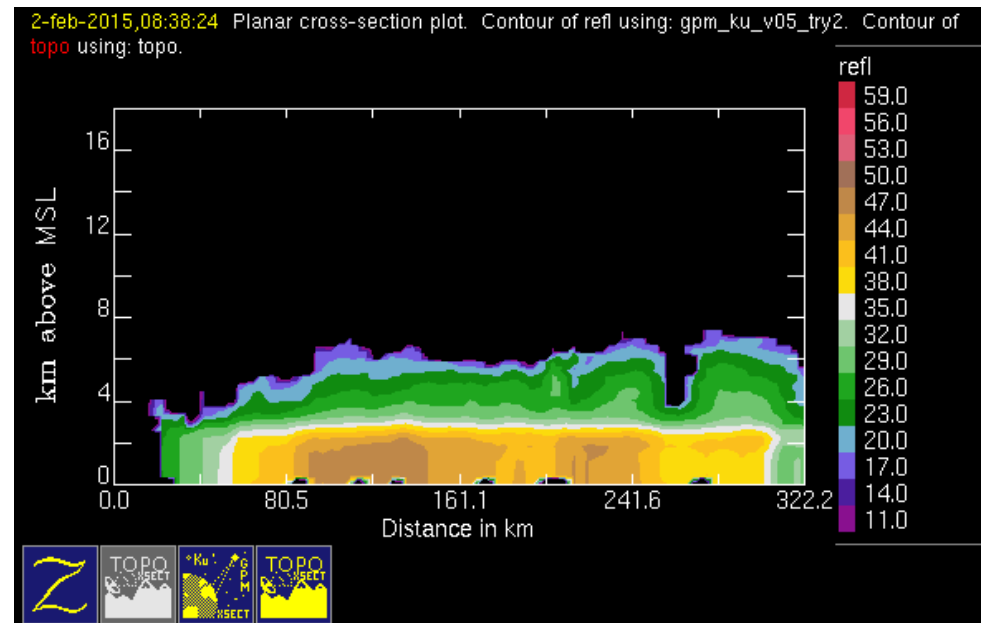
(20150202/0839)

Solving this remaining problem is
<u>critical to all applications that depend on
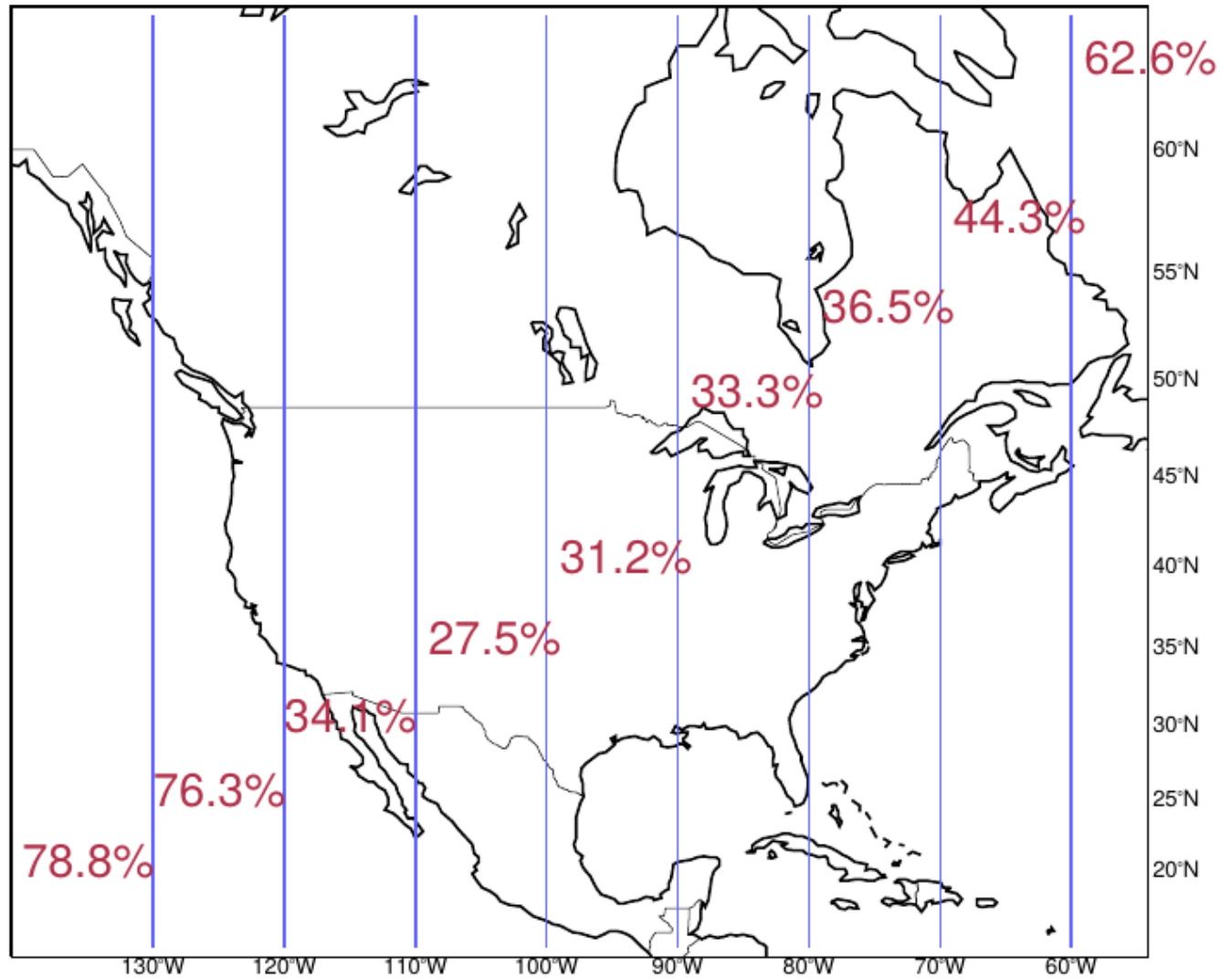convective/stratiform classification</u>

(latent heating, PSD, …)

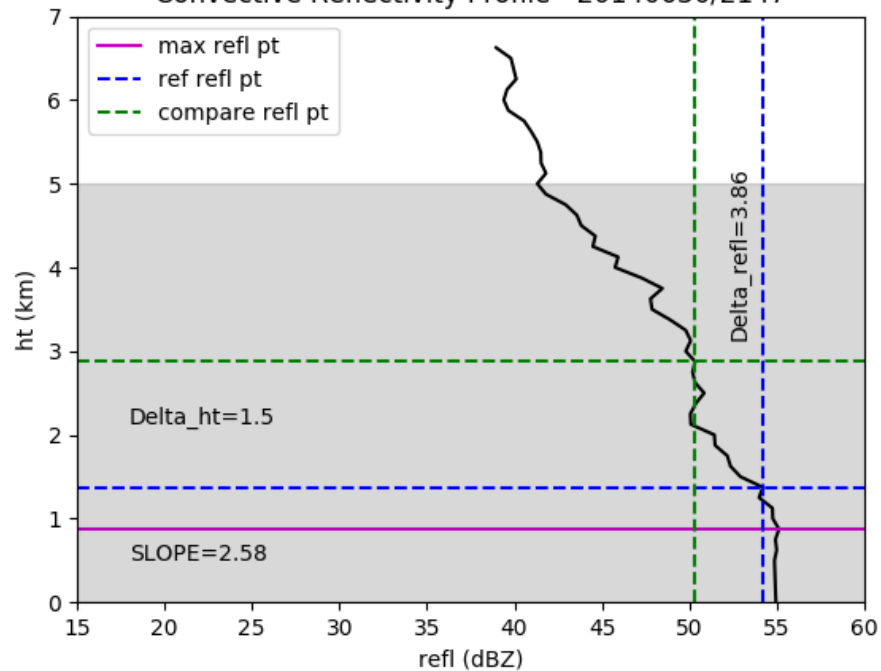# Complicating factors in identifying stratiform echo in GPM data:

- Melting level height varies

- Bright band is often >40 dBZ

- Melting level is not always a sharp peak in dBZ

- Key indicator of SF is a strong drop off in reflectivity above melting level

UW add-on to V5 C/S algorithm

Test Area

Convective Reflectivity Profile - 20140630/2147
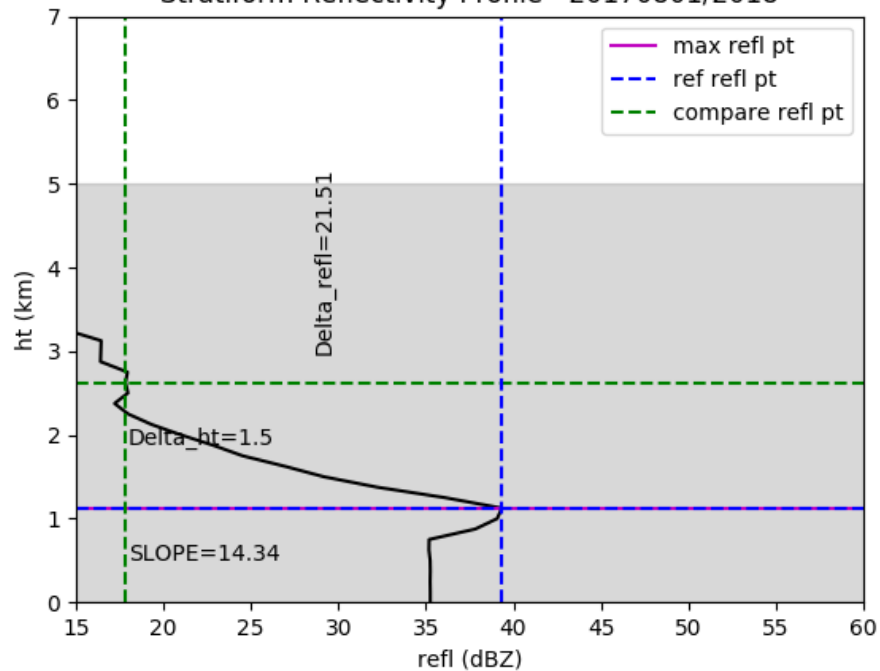
Delta_refl=3.86
Delta_ht=1.5
SLOPE=2.58

Stratiform Reflectivity Profile - 20170801/2018

Delta_refl=21.51
Delta_ht=1.5
SLOPE=14.34

Reclassified Stratiform Reflectivity Profile - 20140630/2147

Delta_refl=12.8
Delta_ht=1.5
SLOPE=8.53

**Reclassified Stratiform Reflectivity Profile - 20170801/2018**

Delta_refl=17.33
Delta_ht=1.5
SLOPE=11.55

Legend (all panels):
— max refl pt
-- ref refl pt
-- compare refl pt

Axis labels: ht (km), refl (dBZ)

Problem case: East Coast Front

October
NE U.S.

(20141022/1132)

# Problem case: West Coast Front

December
NW U.S.

(20141224/1202)
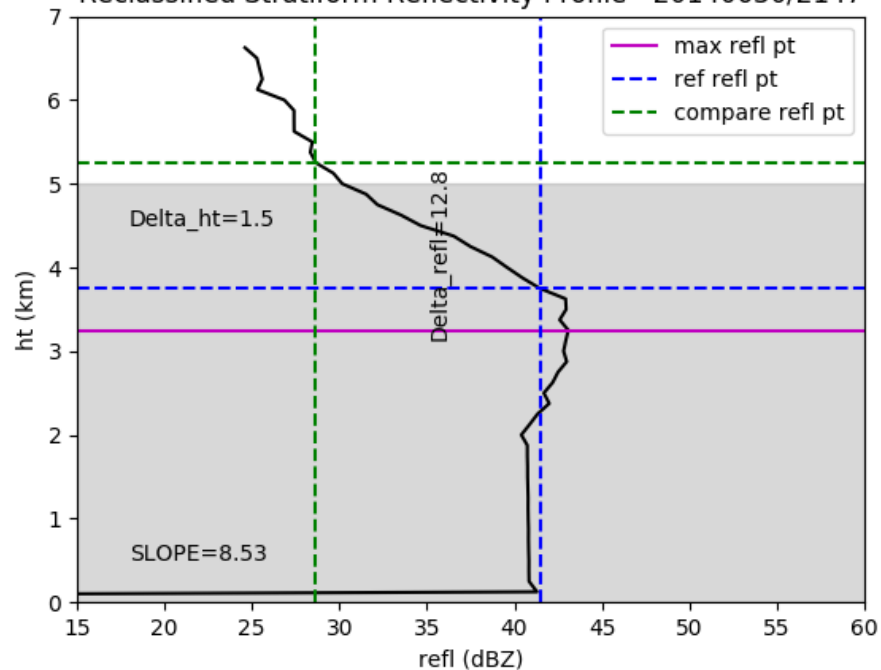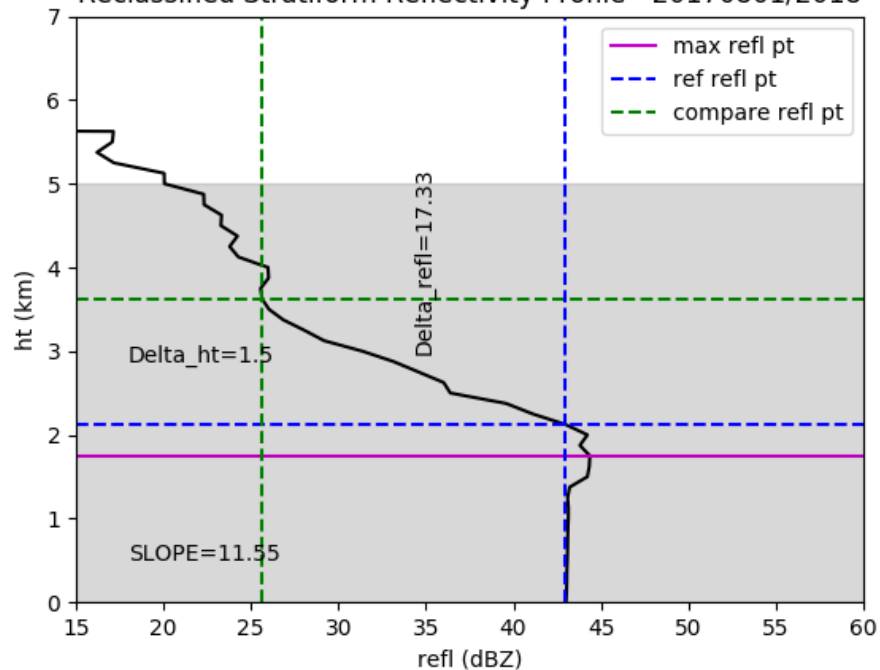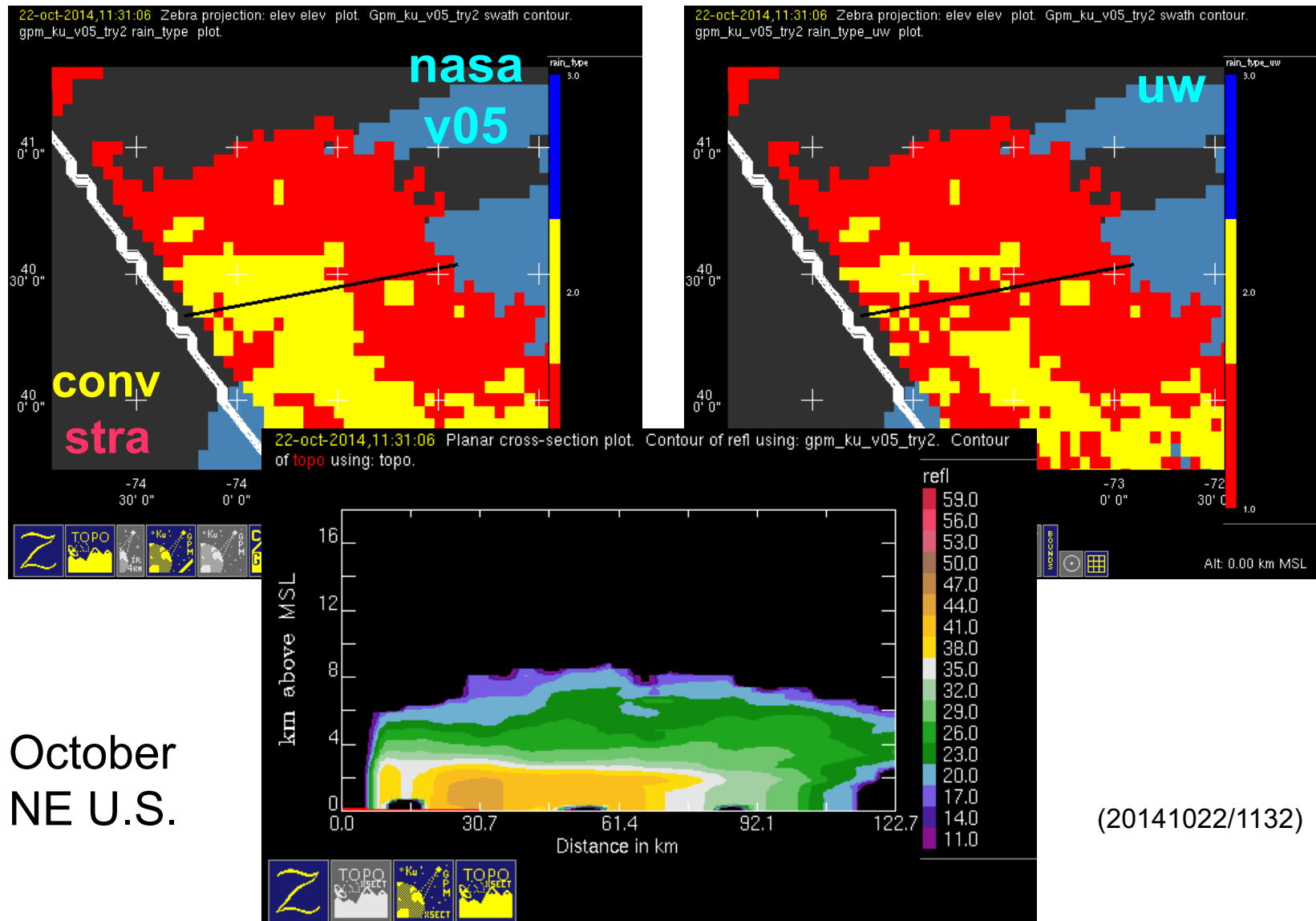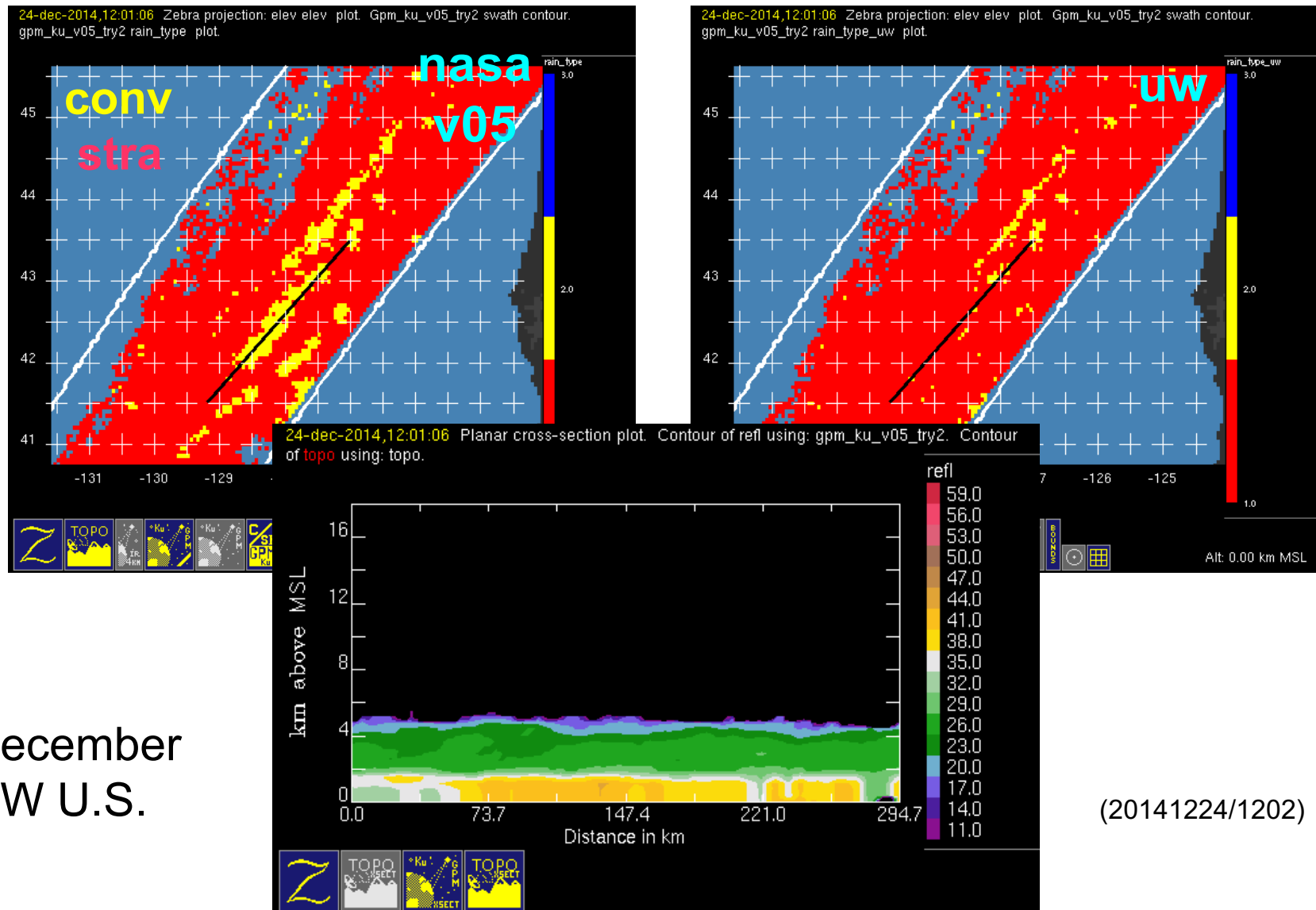
Problem case: North Pacific
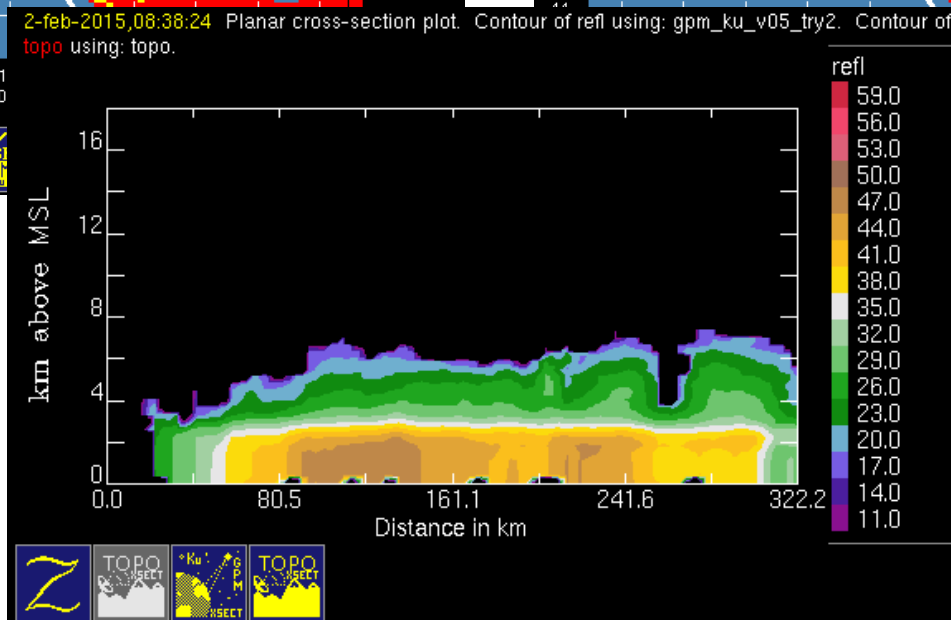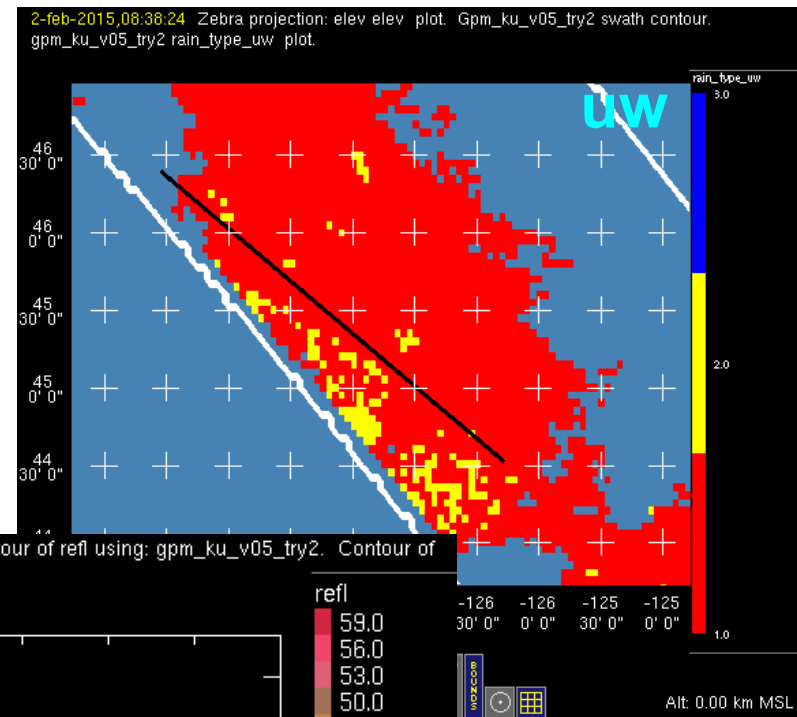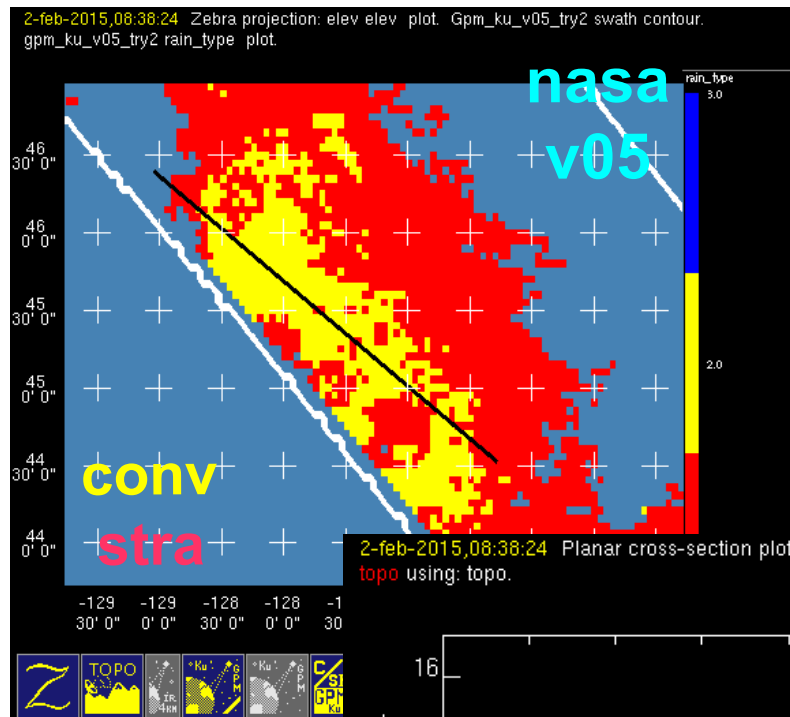
February
North Pacific

(20150202/0839)

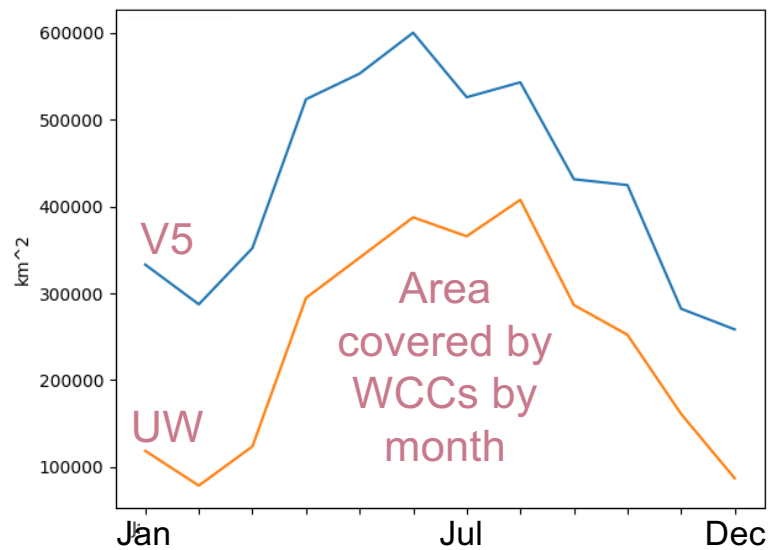| Object	Echo Characteristic	Height	Area
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			30-50,000 km^2 (filtered)

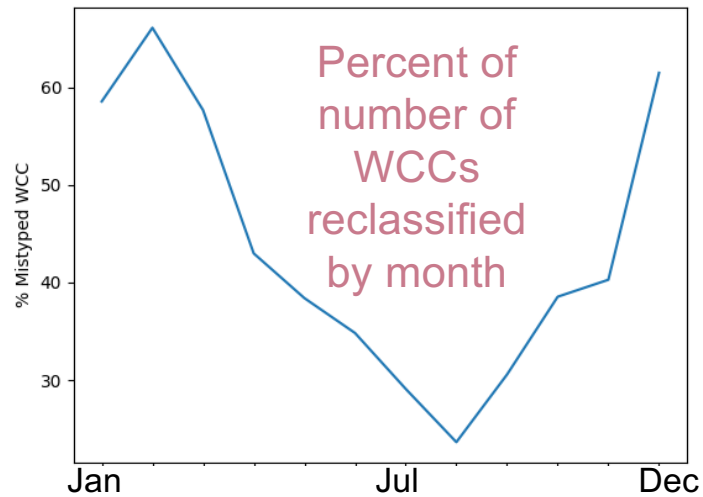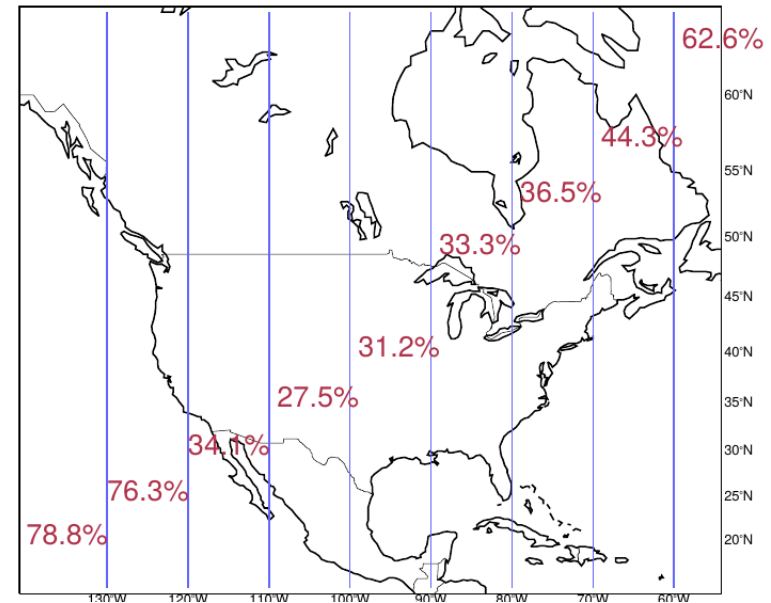# Comparison of v05 Counts NASA/UW (strong thresholds)
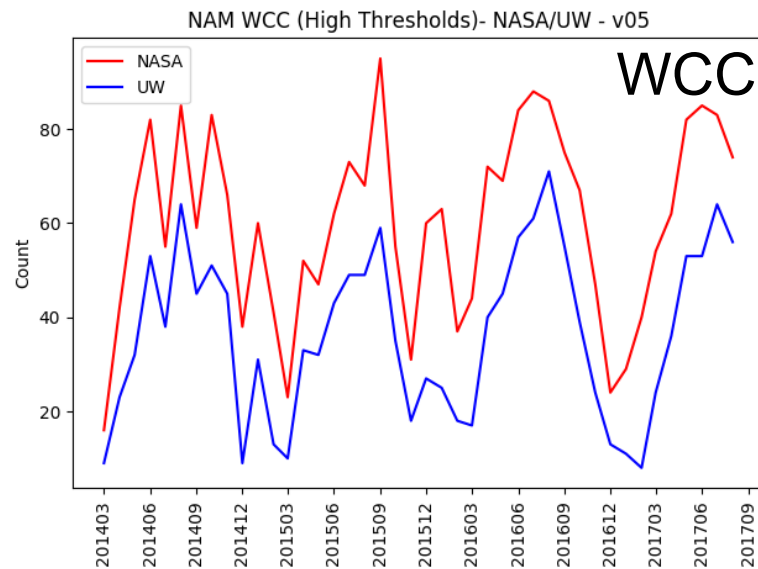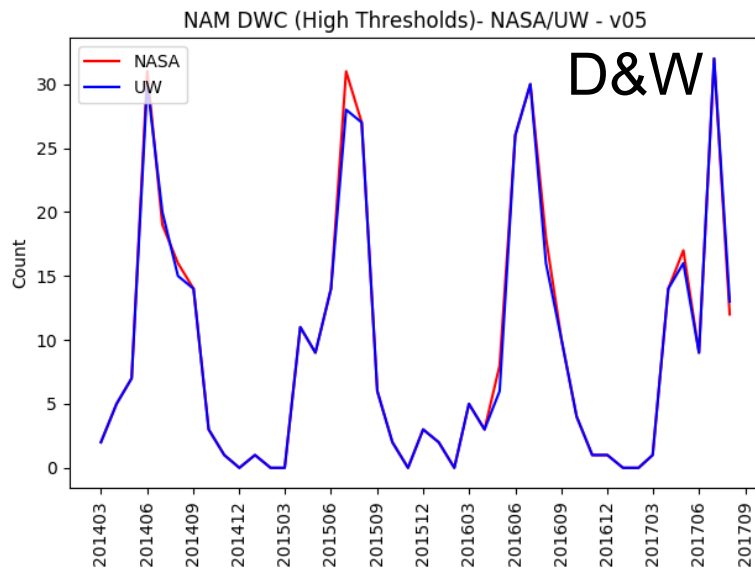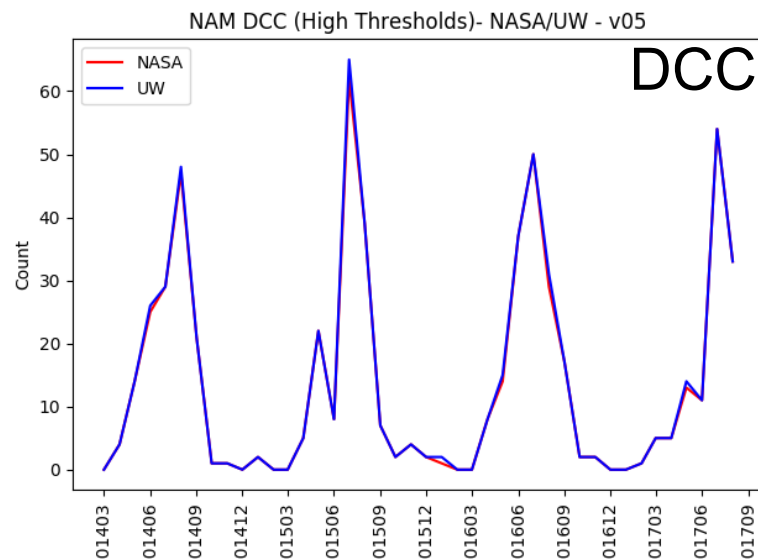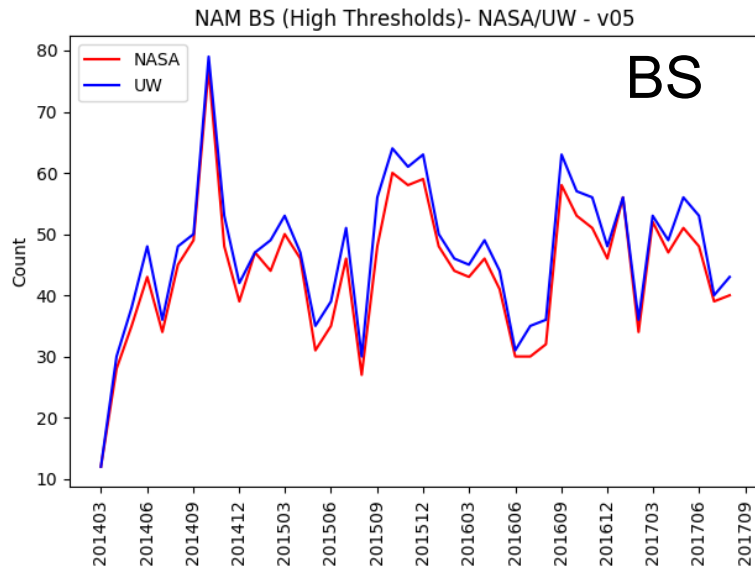
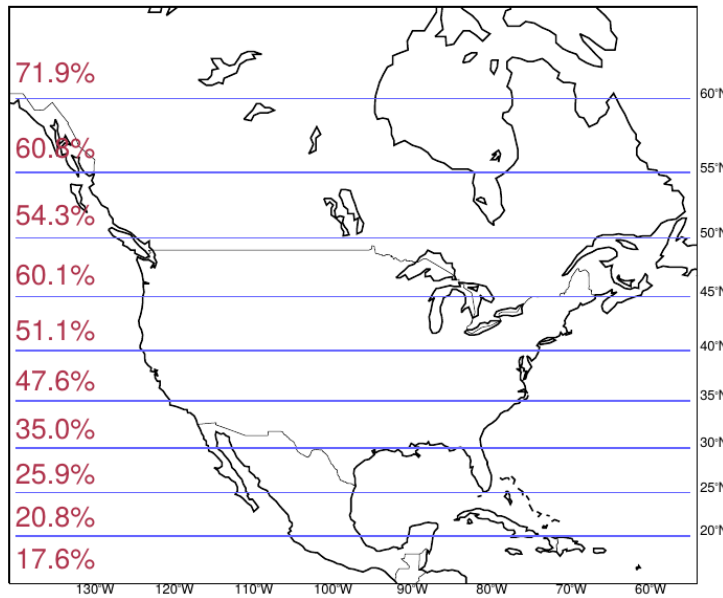# Comparison of v05 Counts NASA/UW (moderate thresholds)
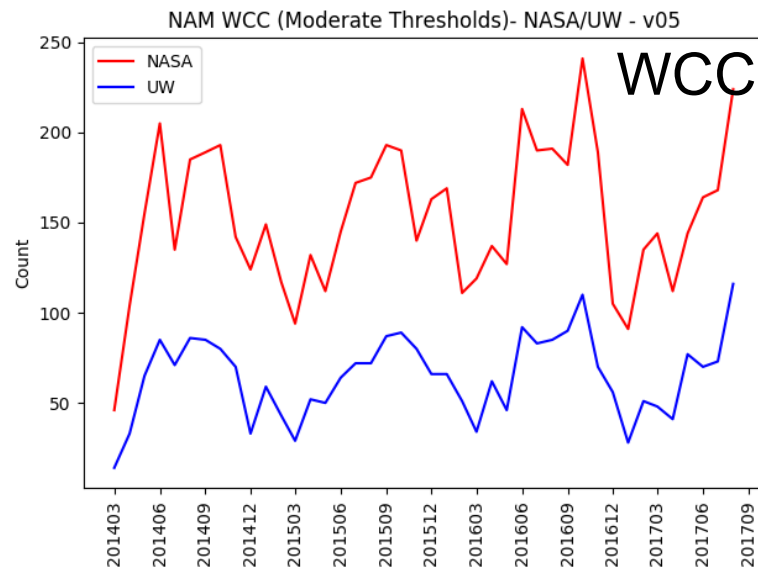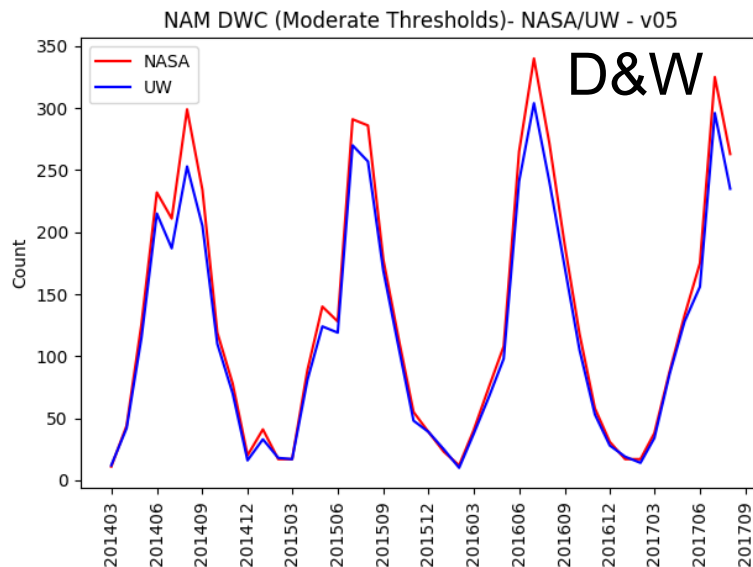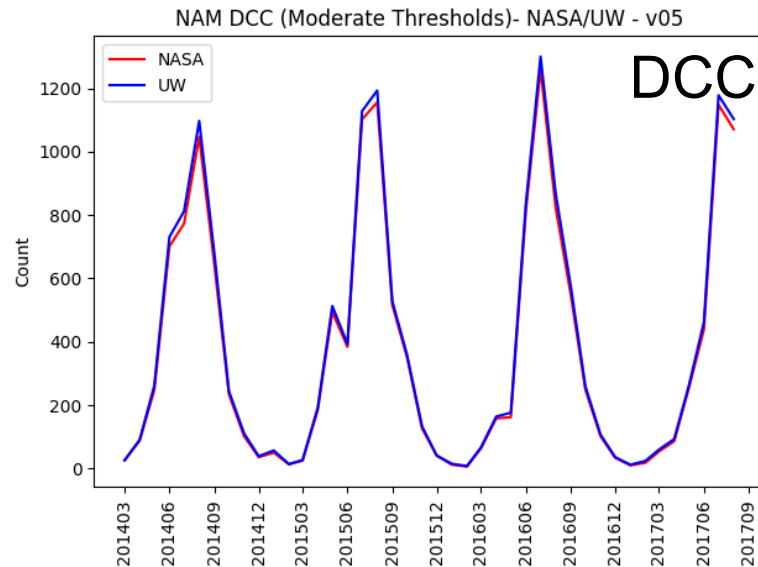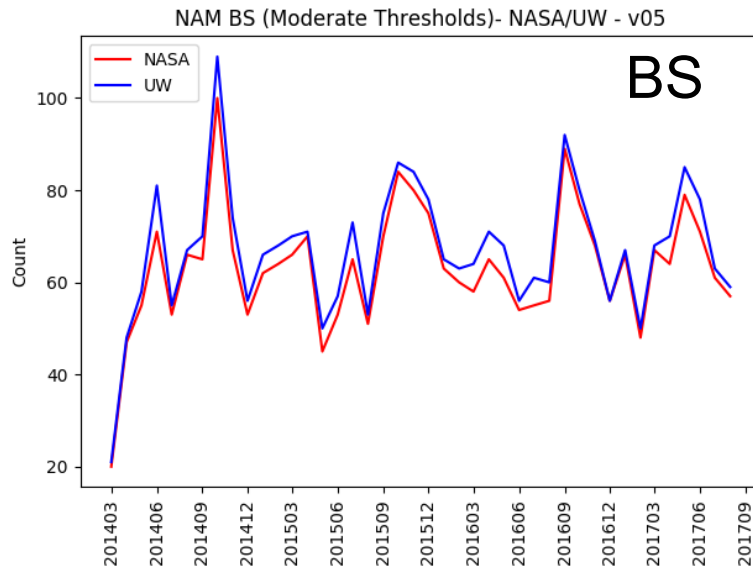
Percentage of WCCs reclassified by UW add-on
(strong threshold cases)

Top-left map (percentages by latitude):
71.9%
60.6%
54.3%
60.1%
51.1%
47.6%
35.0%
25.9%
20.8%
17.6%

Top-right map (percentages by longitude):
62.6%
44.3%
36.5%
33.3%
31.2%
27.5%
34.1%
76.3%
78.8%

Bottom-left: Percent of number of WCCs reclassified by month
(Y-axis: % Mistyped WCC; X-axis: Jan, Jul, Dec)

Bottom-right: Area covered by WCCs by month
(Y-axis: km^2; X-axis: Jan, Jul, Dec; V5, UW)

PROBABILITY MAPS (BASED ON GPM-Ku v05, 2014-2017)

(a) DJF broad stratiform regions strong thresholds
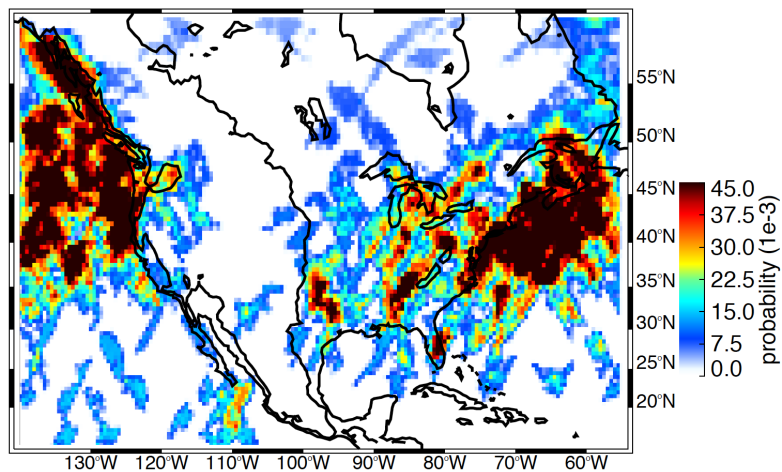
(b) DJF deep convective cores strong thresholds
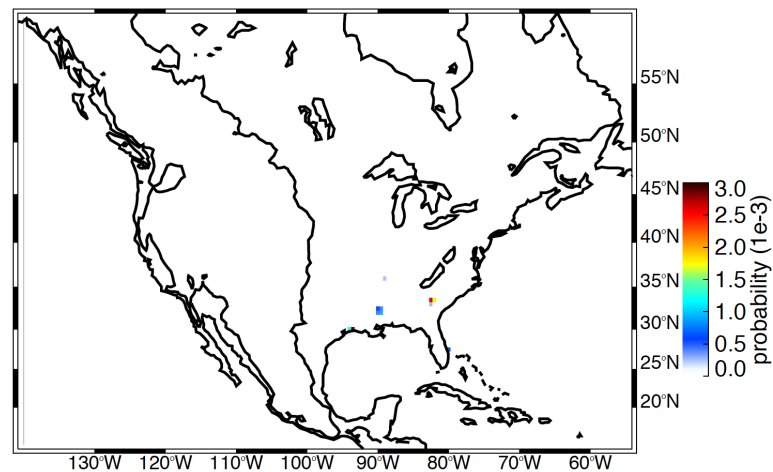
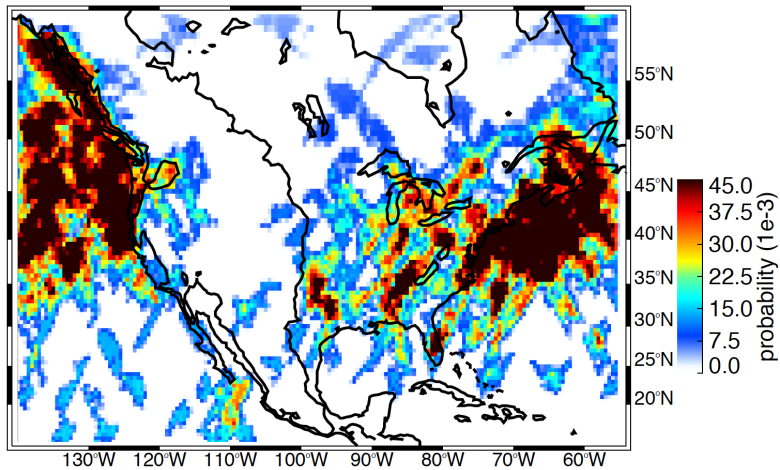## (c) DJF deep/wide convective cores strong thresholds
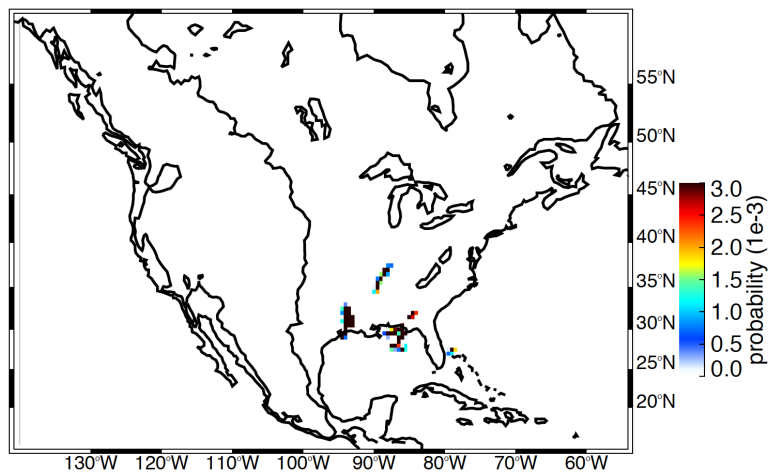
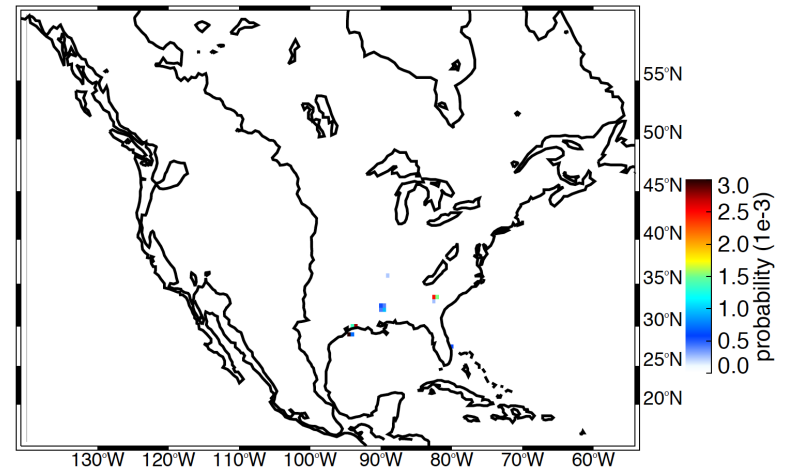## (d) DJF wide convective cores strong thresholds
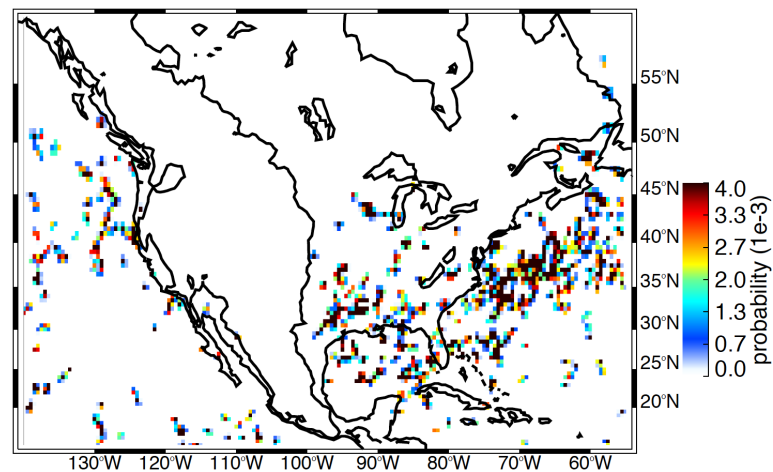
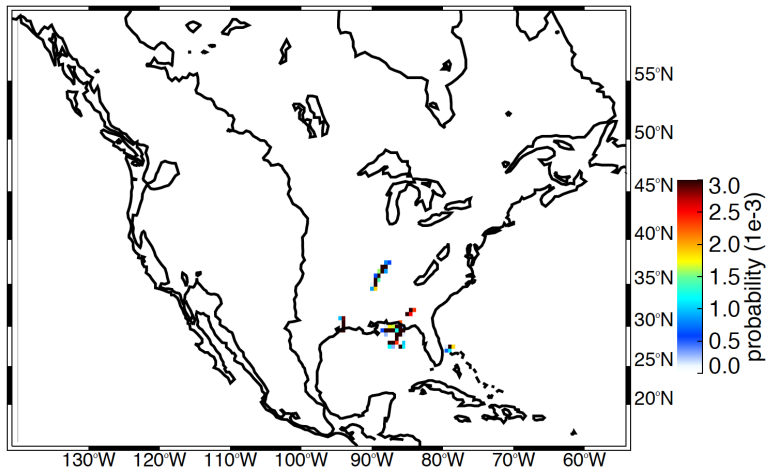PROBABILITY MAPS (BASED ON GPM-Ku v05uw2, 2014-2017)

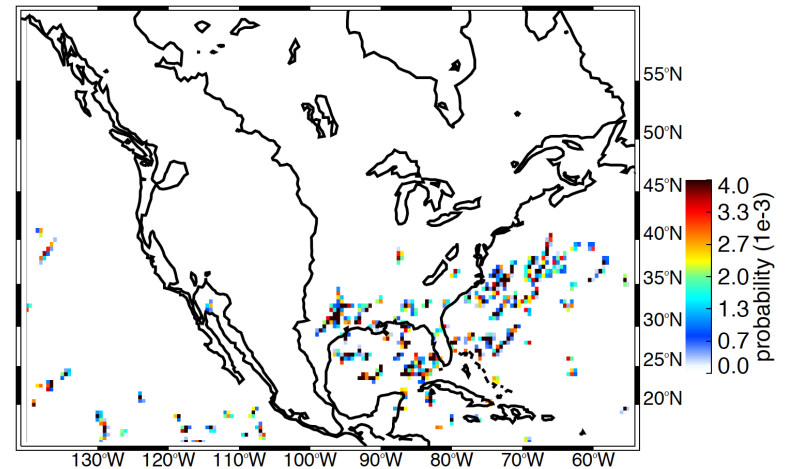(a) DJF broad stratiform regions strong thresholds (uw2)

(b) DJF deep convective cores strong thresholds (uw2)

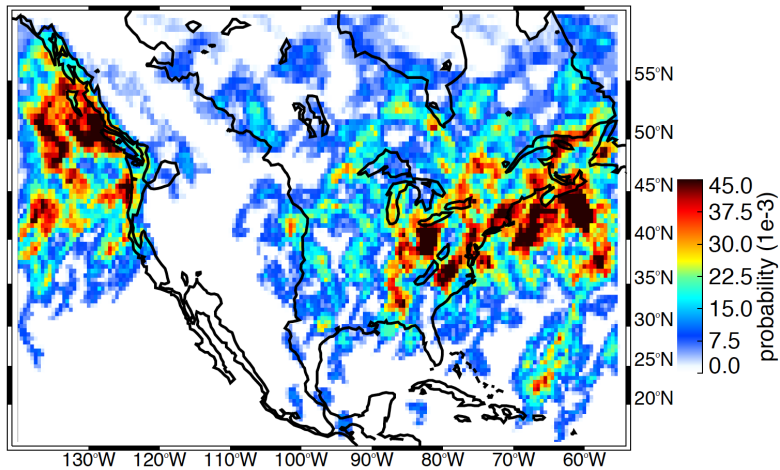(c) DJF deep/wide convective cores strong thresholds (uw2)
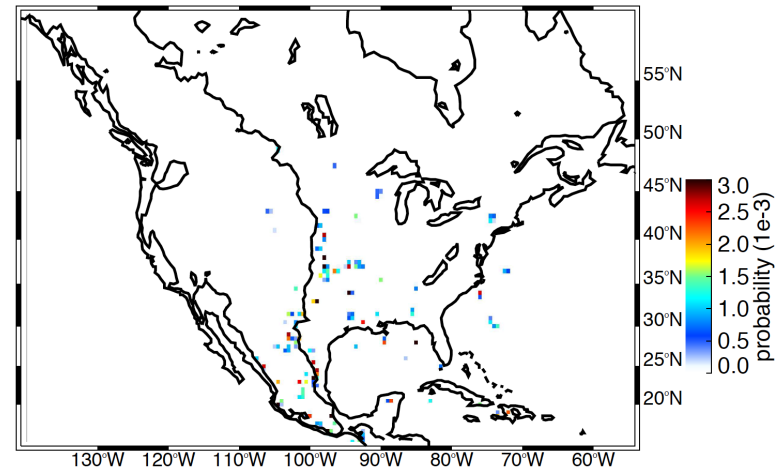
(d) DJF wide convective cores strong thresholds (uw2)

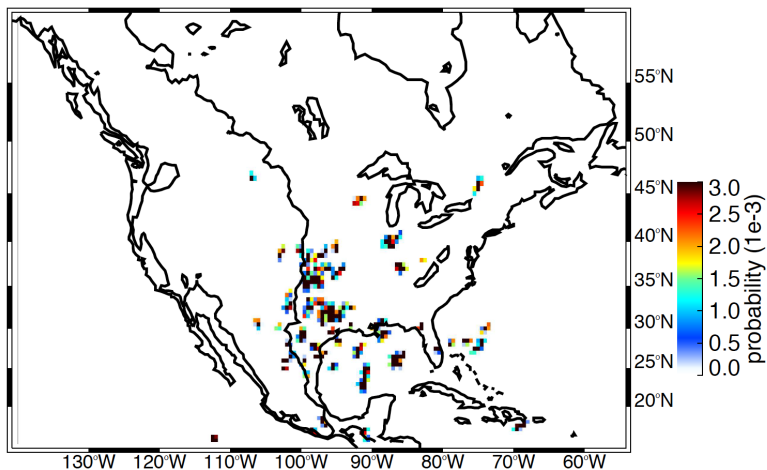PROBABILITY MAPS (BASED ON GPM-Ku v05, 2014-2017)

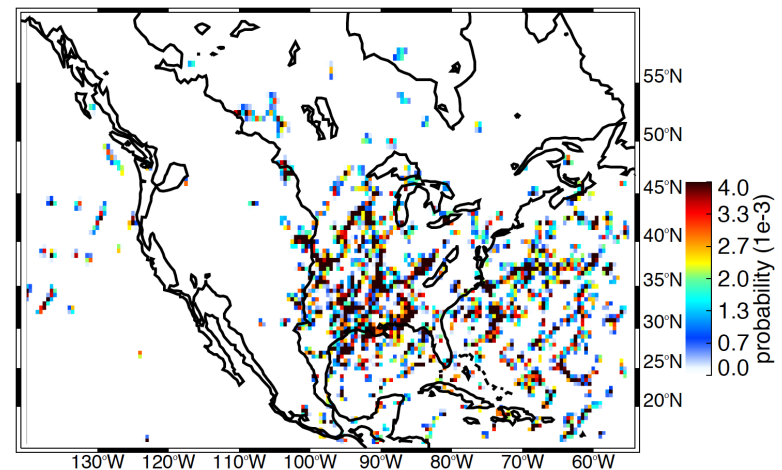(a) MAM broad stratiform regions strong thresholds

(b) MAM deep convective cores strong thresholds

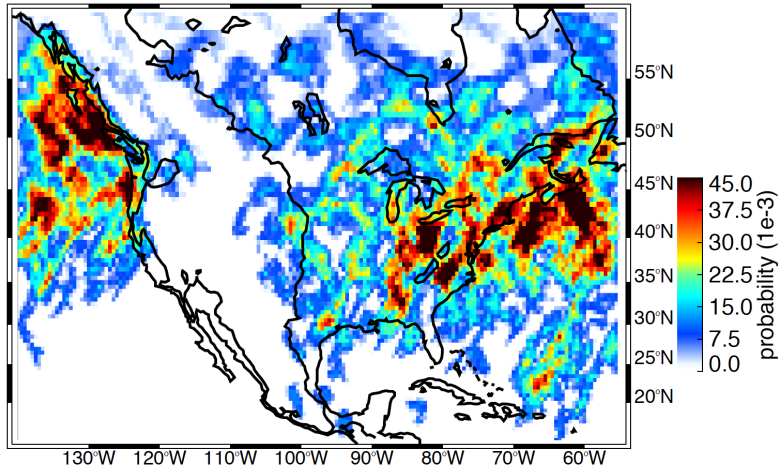(c) MAM deep/wide convective cores strong thresholds

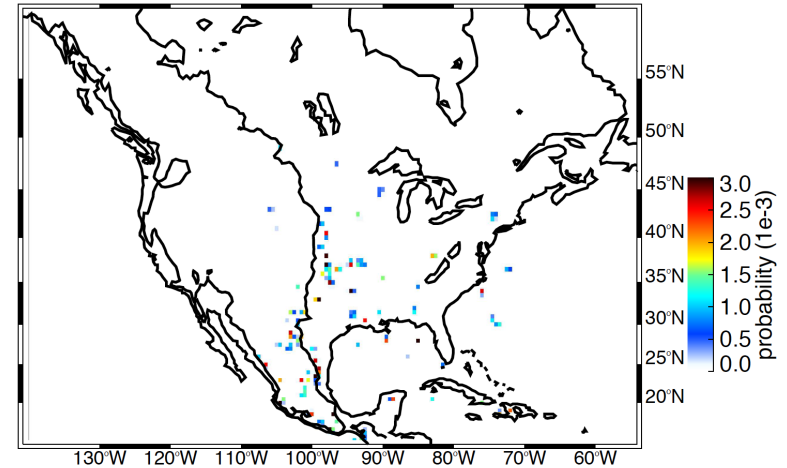(d) MAM wide convective cores strong thresholds

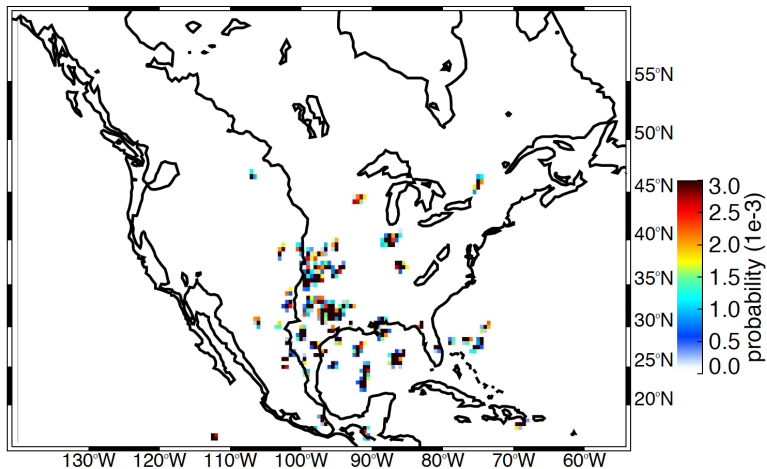PROBABILITY MAPS (BASED ON GPM-Ku v05uw2, 2014-2017)

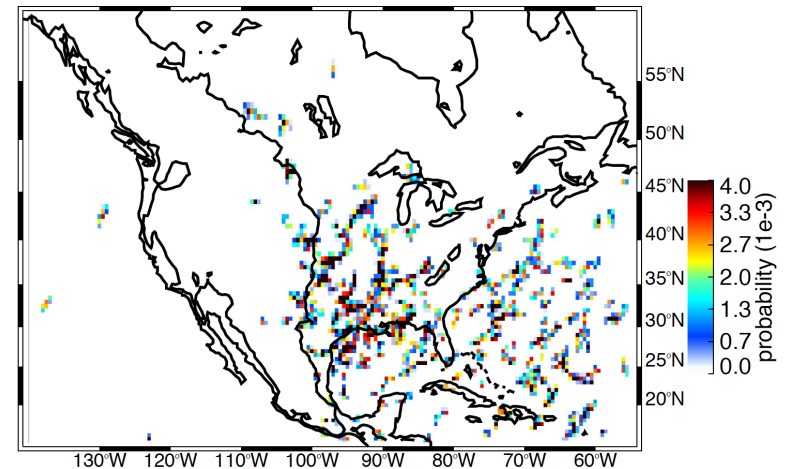(a) MAM broad stratiform regions strong thresholds (uw2)

(b) MAM deep convective cores strong thresholds (uw2)

(c) MAM deep/wide convective cores strong thresholds (uw2)

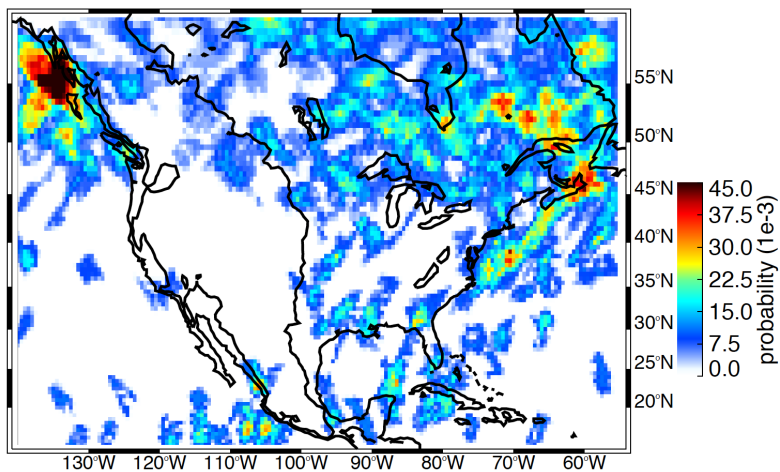(d) MAM wide convective cores strong thresholds (uw2)

Conclusions

- V5 performs better than V4 but still indicates a lot of stratiform as convective → overestimation of convective latent heating

- An algorithm based on the dropoff of reflectivity above the maximum dBZ eliminates most of the problem

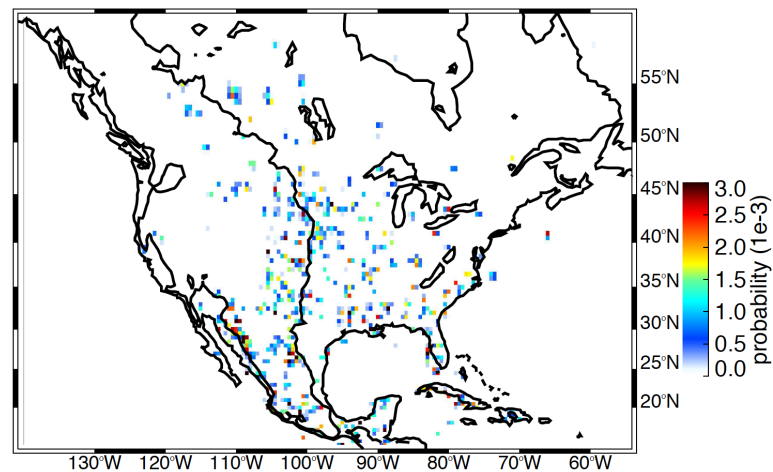- Over the North America sector, the problem is greatest in winter and spring, at higher latitudes, & over the ocean

Extra Slides
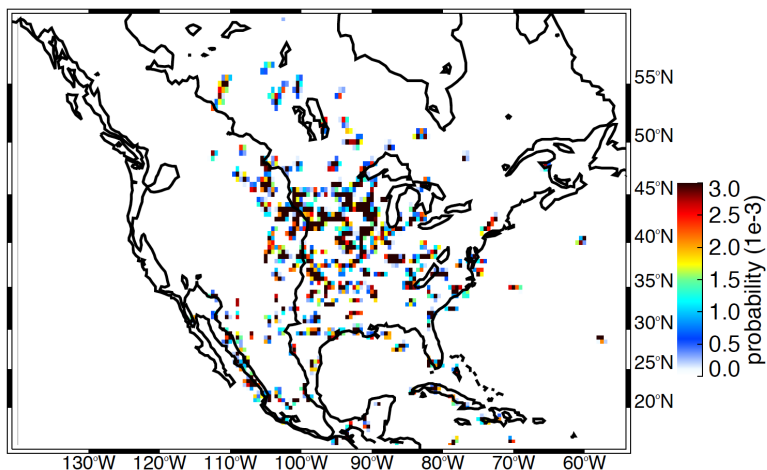
PROBABILITY MAPS (BASED ON GPM-Ku v05, 2014-2017)

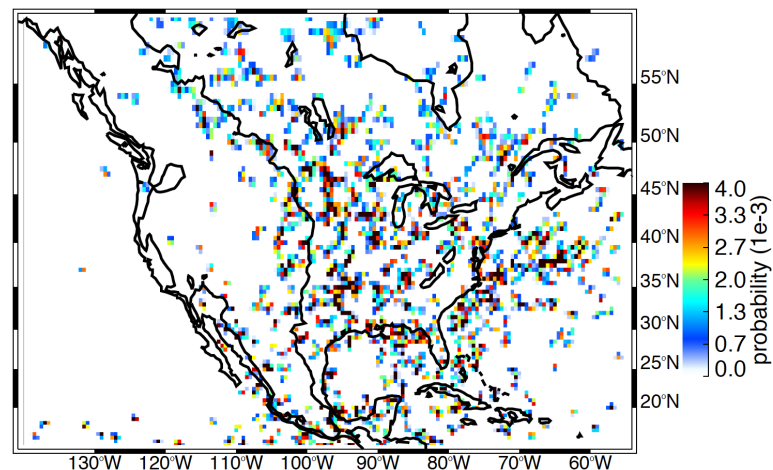(a) JJA broad stratiform regions strong thresholds

(b) JJA deep convective cores strong thresholds

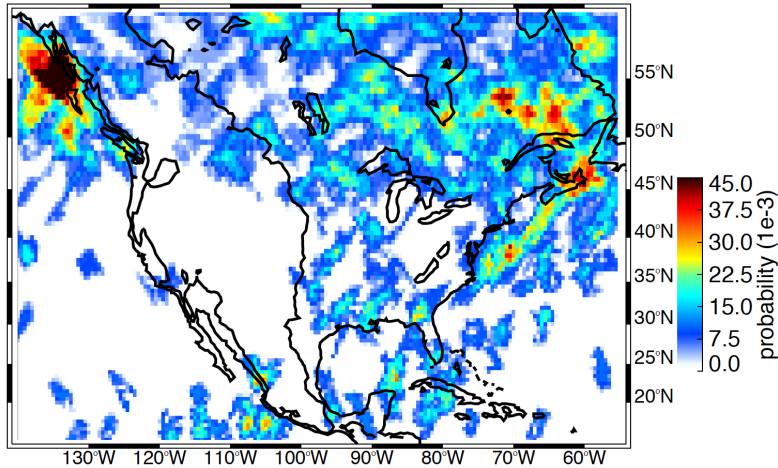(c) JJA deep/wide convective cores strong thresholds
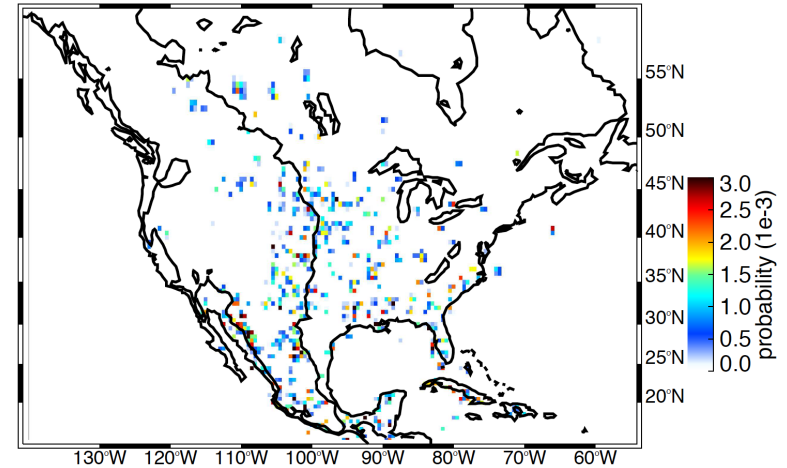
(d) JJA wide convective cores strong thresholds

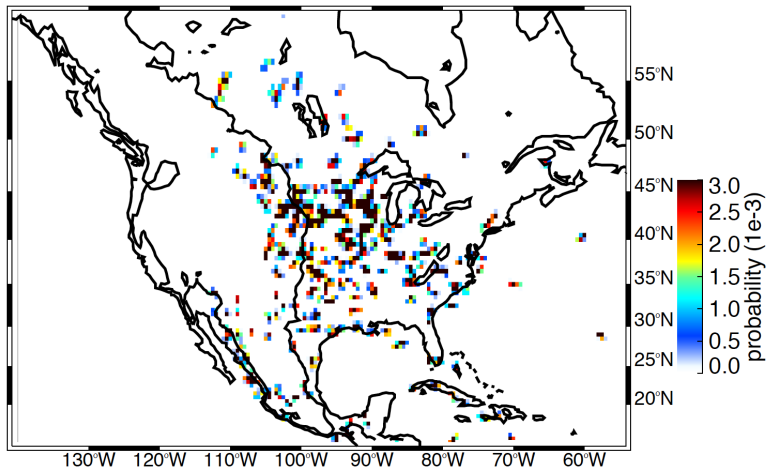PROBABILITY MAPS (BASED ON GPM-Ku v05uw2, 2014-2017)

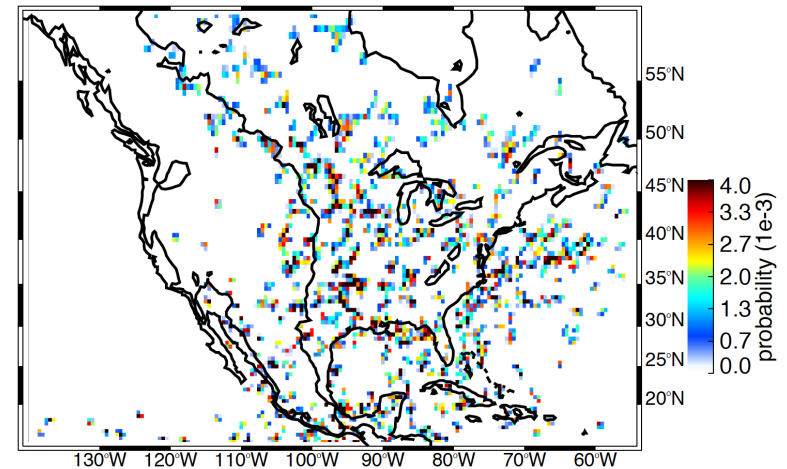(a) JJA broad stratiform regions strong thresholds (uw2)

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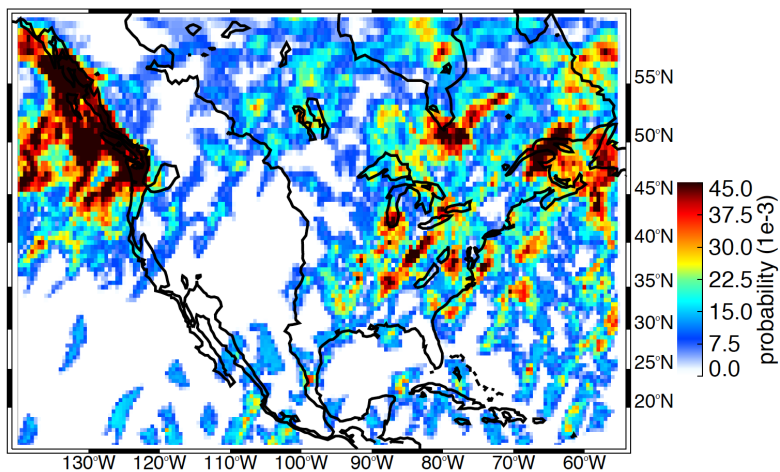(c) JJA deep/wide convective cores strong thresholds (uw2)

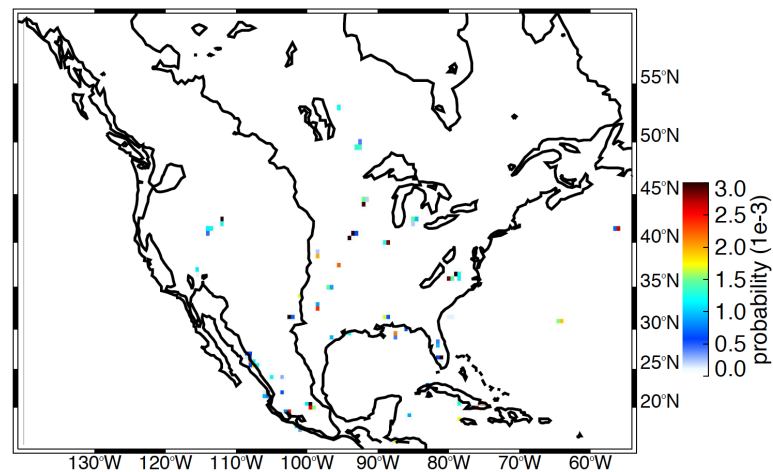(d) JJA wide convective cores strong thresholds (uw2)

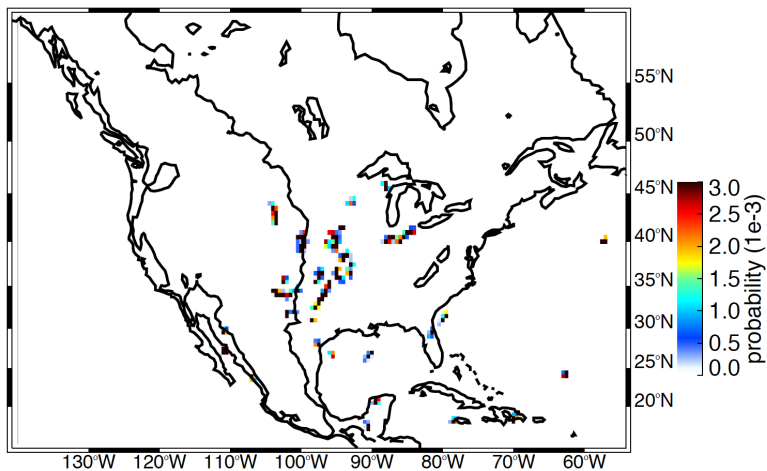# PROBABILITY MAPS (BASED ON GPM-Ku v05, 2014-2016)
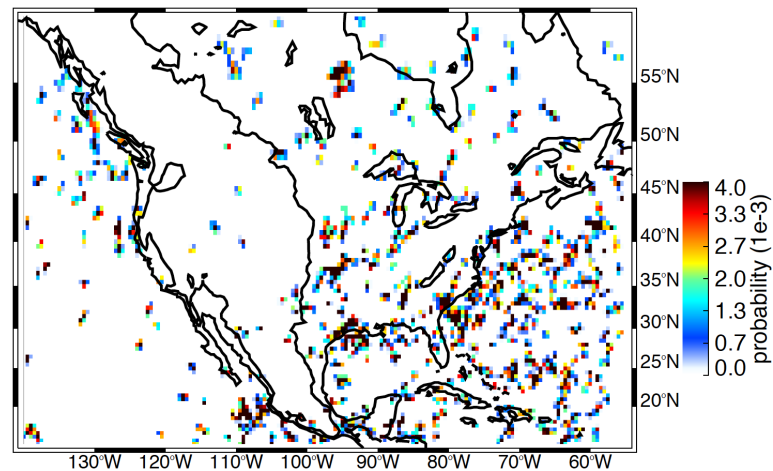

(a) SON broad stratiform regions strong thresholds

(b) SON deep convective cores strong thresholds

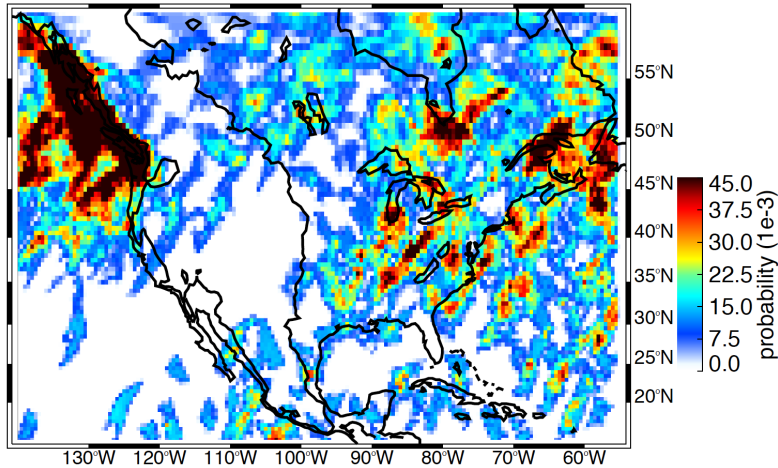(c) SON deep/wide convective cores strong thresholds

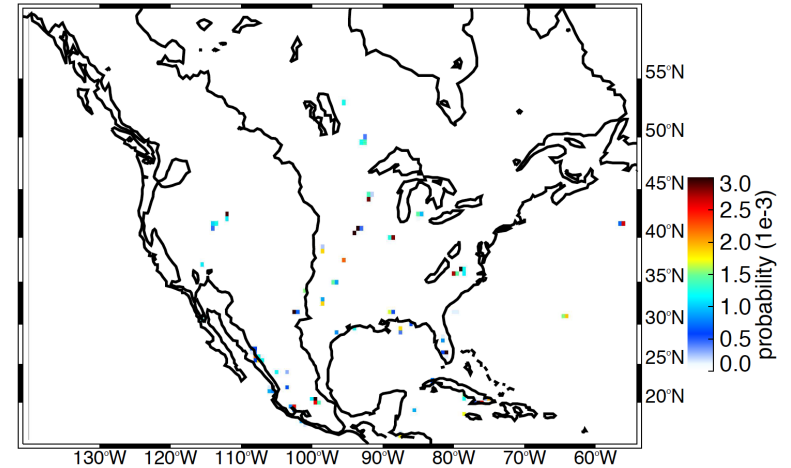(d) SON wide convective cores strong thresholds

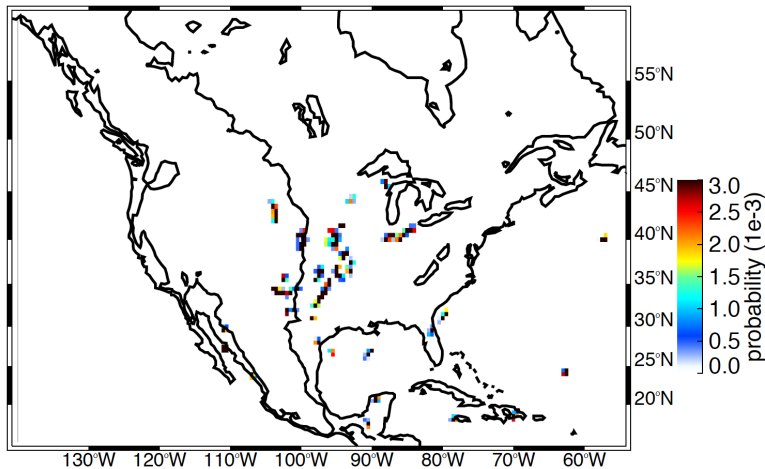# PROBABILITY MAPS (BASED ON GPM-Ku v05uw2, 2014-2016)

(a) SON broad stratiform regions strong thresholds (uw2)

(b) SON deep convective cores strong thresholds (uw2)

(c) SON deep/wide convective cores strong thresholds (uw2)

(d) SON wide convective cores strong thresholds (uw2)